Life Cycle Sustainability Assessment of electricity from Straight Jatropha Oil. Ecuadorian case.

Muñoz, M [1] ; Herrera, I [2]; Lechón, Y [2]; Iglesias, E [1] ([1]Economics Applied to Agriculture, Food and Natural Resources UPM [2]Energy Systems Analysis Unit. CIEMAT.)

Introduction

The Galapagos archipelago as symbol for the theory of evolution is especially vulnerable to all negative effects of fossil fuels [Gruber, 2014]. Situated in the Pacific some 1,000 km from coast of Ecuador, the Galapagos Islands have been inscribed in the UNESCO world heritage since 1978. Later on, in 2007 UNESCO put the Galápagos Islands on their List of World Heritage in Danger [ISES, 2011]. The Zero fossil fuels Initiative, on the Galapagos Islands, aims to replace the diesel used for power generation in Floreana Island, by Straight Jatropha Oil (SJO) growing in the province of Manabi [GIZ, 2014]. The generation of this electricity contributes to the mitigation of climate change, rural development and conserving land for use different to energy, leading to positive impacts on environmental, economic and social aspects [GIZ, 2014]. A Life Cycle Assessment (LCA) was conducted for blend Diesel-SJO based electricity generation. Furthermore, a comparative analysis was generated for three scenarios: blend system (D80-SJ020) SJO system (SJO100) and Diesel system (D100). Finally sustainability assessment of electricity production system, was developed.

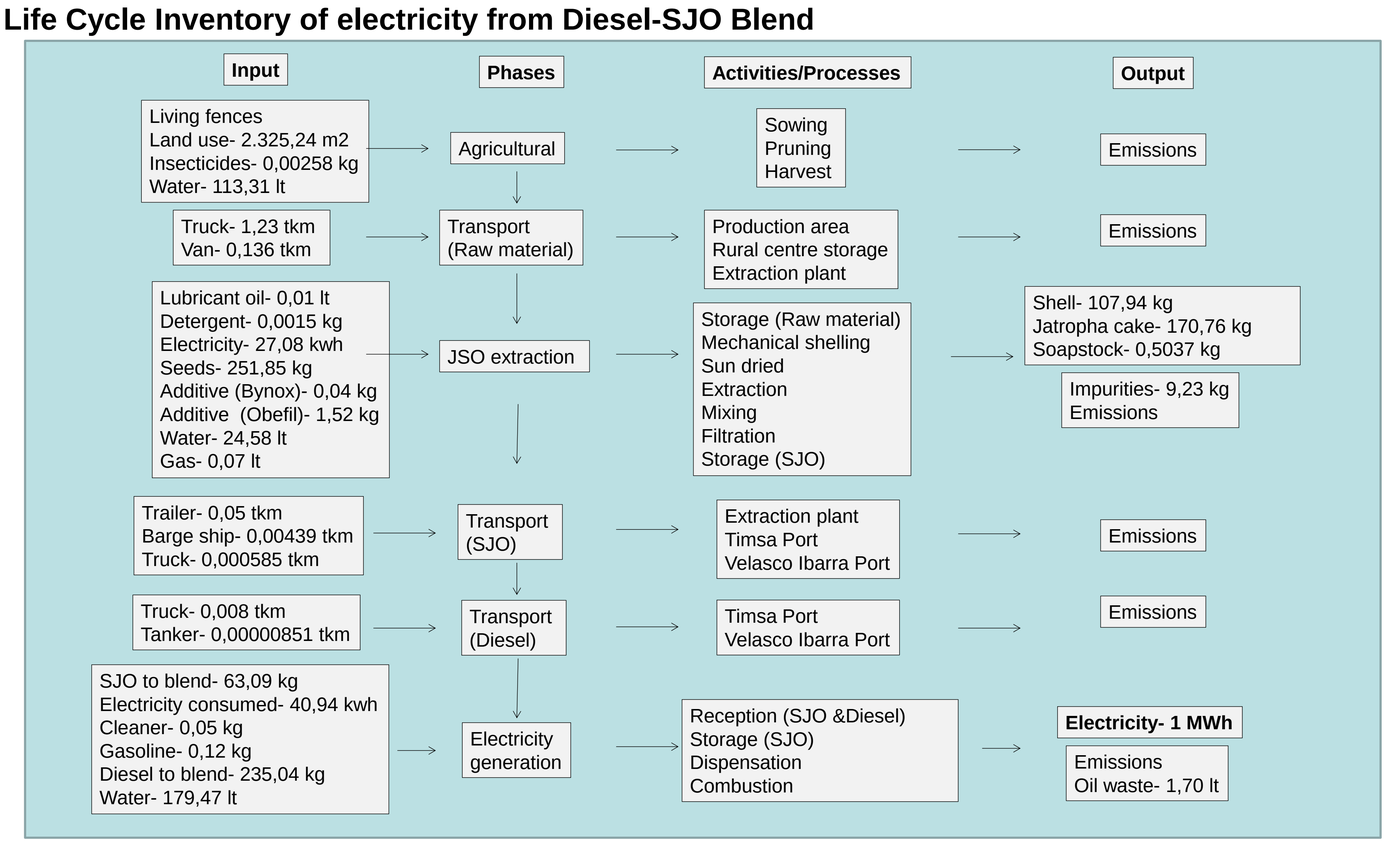
Materials and Methods

The environmental implications associated with the electricity generation in engines that are able to run with diesel, 100% pure Jatropha oil or with any blend of both fuels. In this study, a blend of 80% diesel and 20 % pure Jatropha oil, has been analysed.

For JSO supply, the so-called "Living Fence" concept collecting Jatropha seeds by farmers and families from already existing 7.000 km hedges on Manabí was chosen. The Jatropha oil is produced in a decentralized so-called CompacTropha oil mill container following the ambitious German fuel quality standard DIN51605 [Gruber G, 2014].

For LCA 1 MWh was selected as Functional Unit (FU) and raw material extraction, refinery and generation were considered as steps of electricity chain.

Life Cycle Inventory of electricity from Diesel-SJO Blend



Climate change (kg CO2eq/MWh)

	Raw material		Electricity	
Scenarios	Extraction	Refinery	generation	Total
D80 - SJ020	0,55	20,72	784,30	805,58
SJO 100	4,15	155,38	38,61	198,14
D 100	5,34	87,20	835,86	928,41
CO2eq saved				13,23%

Fossil energy consumption (GJ/MWh)

	Raw material		Electricity	
Scenarios	Extraction	Refinery	generation	Total
D80 - SJ020	0,01	0,41	10,38	10,80
SJO 100	0,06	3,09	0,52	3,67
D 100	12,21	0,00	0,05	12,27
F. Energy saved				12%

Social & economical Benefits (MWh)

	Unit	(D80-JO20)
Jatropha seed	kg	251,85
Fruit gathering	Small farmer	2
Benefit by each small farmer	U$	39,18

Land use savings (MWh)

	Unit	(D80-JO20)
*Land use (LF)	km	0,39
**Land use (MC)	ha	0,23
*LF (Living fences)		
**MC (Monoculture)		

Results and discussion

Environmental aspects

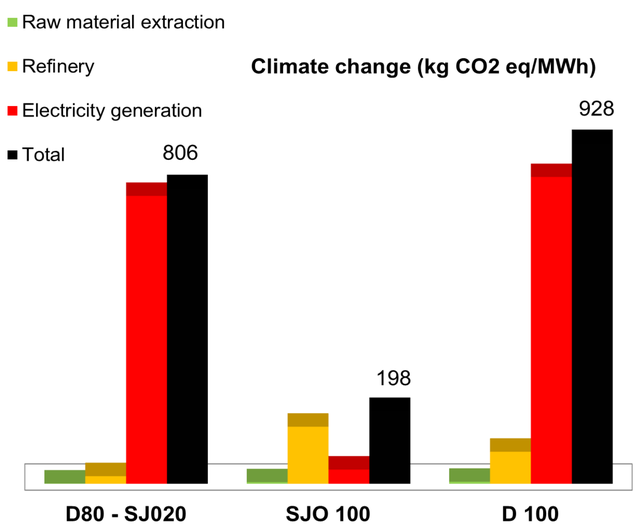
From an environmental point of view, production of a 1MWh generated whit the D80-SJO20 blend, shows savings for climate change and energy fossil consumption of 122,83 kg CO2eq (13,2%) and 1,5 GJ (12,0%) respectively, regarding to Diesel system (D100). For both categories, electricity generation phase, it is the major contributor with 97,35% in the case of climate change and 96,11% for energy consumption.

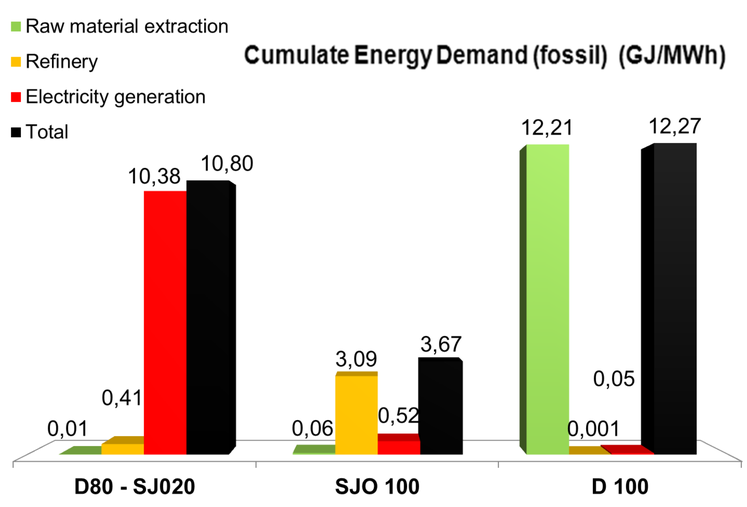
Social Aspects

From a rural development perspective, annual demand of electricity production in island Floreana involves 724 smallholders. In other words, each 1MWh benefits to 2 smallholders.

Resources

Another benefits identified, related to an better land use, is the saving in cultivable soil. Each MWh generated with 20% of jatropha oil of living fences may to avoid using of 0,23 ha of cultivable soil.





Conclusions & Future work.

Electricity supply on the Floreana Island has converted to an appropriate mix of renewable energies. Power generators running with blend D-JSO, play a key role in sustainable energy sources, environmental protection and the reduction of greenhouse gases and energy fossil consumption.

The financially viable production of jatropha oil by smallholder farmers meets the demands of these power generators in terms of both quantity and quality. At the same time, the jatropha oil production helps farmers to diversify their incomes and drive sustainable rural development in the Manabi province. The whole chain from the Jatropha plantation up to the collection of seeds and production of Jatropha oil constitutes a new source of income for population.

Finally, the land use savings by living fence as crop, shows a great possibility to decrease pressure for cultivable soils, which can be used for others requirements different to energy.

REFERENCES

- ISES, 2011. ISES 2011. Proceedings International Solar Energy Society. *High Penetration PV- Battery-Straight Vegetal Oil Hybrid System for Zero Emission Electricity Generation on the Galapagos Islands* P. Strauss, M. Braun, R. Estrella, S. Karres, W. Klaus, L. Manzano, A. Moreno, I. Rodriguez Ortiz, A. Samaniego. August 28 - September 2, 2011 Kassel, Germany P
- GIZ,2014, Renewable Energy for Galápagos (ENERGAL), Deutsche Gesellschaft für , Internationale Zusammenarbeit (GIZ),
- Gruber G, 2014. Pure Jatropha Oil for Power Generation on Floreana Island/Galapagos: Four Years Experience on Engine Operation and Fuel Quality Journal of Energy and Power Engineering 8 (2014) 929-938. David Publishing, 31/05/2014